

N7873152



FORWARD

The Silicone Rubber Specialties Company submits this final report to the National Aeronautics and Space Administration, LBJ Space Center. The report has been prepared in response to Contract NAS 9-14242, the Design, Development and Manufacture of Future Docking Interface Seals for a manned Spacecraft Docking System. The development work herein reported on was conducted between July, 1974 and September, 1975.

We wish to acknowledge the contributions of Richard F. Smith, the Contracting Officer's Technical Monitor for Spacecraft Design. Mr. Smith played a significant role in helping overcome the major problems encountered during the performance of this contract.

INTRODUCTION AND SUMMARY

1.0 PURPOSE

1.1 OBJECTIVE

The work performed on NASA Contract NAS 9-14242, The Design, Development and Manufacture of Future Docking Interface Seals for a Manned Spacecraft Docking System is described in this report. The overall objective of this program was to solve the primary problem of cohesion or adhesion and the compressive force of the pressure seal of one spacecraft to the pressure seal of another in the thermal vacuum environment, as subjected to in space. NASA Houston recognized that the existing technology for spacecraft seals would not be satisfactory for long duration space missions. The only material suitable for the extremes of hot and cold with enough resiliance is silicone rubber. The disadvantage of using silicone rubber is the fact that it develops a bond to metal and/or other parts in the thermal vacuum environment of space. An attempt was made to overcome this problem through mechanical design by making the sealing surface round rather than flat. A major disadvantage was leak rate, especially with a mismatch in alignment. It was recognized that space missions of the future could not tolerate the amount of lost oxygen that mismatch would cause. The rewards of being able to perform longer missions on less oxygen is considered of great importance. With a target of less than 10G/hr. @550 MM (.223 pounds/hr. @ 21.65 in) of mercury at a temperature of -50°C (-58°F) and a ΔP of 828 MM of mercury (16 psi.

1.2 END PRODUCT

The end product consists of three pairs of full sized circular pressure seals designed to be used on spacecraft docking systems in the thermal vacuum environment of space for 30 days or longer. The exact dimensions of the full size seals are on the attached Silicone Rubber Specialties Drawing No. T-1-046. For the purposes of discussion, we will reference a mean diameter of 32.36. The seal was manufactured utilizing Silicone Rubber Specialties Compounds 4221-4, 2270-4 and duPont kapton.

1.3 BACKGROUND

The program commenced in July 1974 and we evaluated the more popular shelf stock silicones that meet federal specification, ZZR 765. Initial

applications centered on Dow Corning (DC) 75. However, it was determined that its modulus was too high and it would be impossible to achieve contractual requirements with metal-to-metal @ 212°F with less than 50#/lin inch of seal.

The next candidate selected was DC55 and was rejected for the same reasons as DC75. General Electric (GE) 5553 was also found to be of too high modulus and unable to sustain the requirements of the compression force. DC35 was evaluated and was still lacking in its contractual requirements in the seal compression force area.

It was determined that a dual durometer seal would be required to meet the specifications. See Figure 5.

The target durometers were 40 duro for the interfacing portion of the seal and 20 duro for the retained portion of the seal. Stauffer Wacker 20 duro was selected and processed into SRS Formula 2270-4. Stauffer Wacker 40 duro was selected and processed into the other SRS Formula 4221-4.

Teflon was considered for the barrier material to prevent the adhesion/cohesion that occurs with silicone in the thermal vacuum environment for the flat sealing surface only. The teflon tested was duPont FEP to Federal Spec LP 389 1 mil thick. This offered the advantage of being able to protect against adhesion/cohesion with no detrimental effect on seal compression and was easily manufactured into the docking seal configuration. (See Figure 1)

Because of the tendency of the elongation in the teflon barrier, the seals deformed on the sealing surface resulting in adhesion/cohesion on both edges outside the teflon barrier, as shown in Figure 2. The solution appeared to be a wrap-around of the teflon barrier as shown in Figure 3.

However, the teflon barrier with wrap-around under extreme compression, (metal-to-metal) deformed as shown in Figure 4.

Teflon was rejected as a barrier because of its tendency to elongation, and the "memory" of rubber exceeded that of the teflon. In short, the advantages of teflon's manufacturing capabilities became a detriment when applied to the finished product in the given environment.

We selected duPont kapton, 5 mil thick, as the barrier material because of its dimensional stability over a wide range of temperatures. Also, it was learned that NASA had information on the outgasing characteristics of kapton film. In general, kapton became the more desirable candidate for space applications, when utilized in this program.

2.0 SCOPE

In order to overcome the adhesion/cohesion problems of the seals, it was anticipated, during the fabrication and testing of the various silicones with a teflon barrier, that a simple solution would be to place a barrier on the sealing surface of one seal. However, NASA pointed out that they wished to develop an international docking seal that would be identical thus assuring docking compatibility of all spacecraft using this seal. We fabricated control size seals approximately 1/3 diameter of full size seals, utilizing five Mil kapton on the sealing surface and 43 durometer in the sealing portion and 18 durometer in the retained portion. This insured negligible deformation at sealing surface resulting in a seal with a minimum contact pressure, thus minimizing rubber-to-rubber contact at both edges outside the kapton barrier.

When tested, the only apparent problem was the inability to get metal-to-metal contact of the docking interfaces (@ 212°F well below 50#/lin.inch), due to the expansion of the silicone at elevated temperatures.

It appeared at this stage of development that the requirements of seal compression force would be impossible to meet when considered in conjunction with the requirements of the mismatched docking leak test. When we lowered the seal cross section to meet (metal-to-metal) contact at high temperature, the leak rate requirements were exceeded at the low temperature. We then changed the cross section of the retained portion of the seal to allow for the thermal expansion of the rubber without sacrificing the height of the seal. This was accomplished by the design depicted in cross section of Figure 5. Fabrication and testing was then performed on three sets of control size seals.

3.0 TECHNICAL REQUIREMENTS

3.1 SEAL COMPRESSION FORCE

The seals were placed in a test fixture and heated to 212°F. A compression force was applied to determine the range required to maintain a seal. Sealing occurred at 4.5 lbs/lin inch of seal pressure and was maintained to contact metal-to-metal (Ref. 32.66 lbs/lin inch of seal) of the docking interface as indicated on attached data sheet.

3.2 PRESSURE RANGE

The results obtained from the seal compression force test was determined as being within the allowable leak rate with a differential pressure of 16 psi GN_2 from the cabin side to the outside as delineated in paragraph 3.2 of the

NASA Work Statement.

3.3 LEAK RATE

The seals were then mounted in the test fixture. Preliminary leakage was 0.001 pounds per hour. The seals and fixture were reduced in temperature to a -58°F and allowed to stabilize. A differential pressure of 16 psi GN_2 was applied and the leak rate measured. Leakage was 0.001 pounds per hour GN_2 .

Seals Set No. 34 utilizing a dual durometer rubber with 5 Mil kapton sealing surface passed all tests with no visible damage at the termination of the tests.

3.4 SEAL COHESION OR ADHESION

The control size docking interface seals were exposed to a temperature of 212°F and a pressure of 1.0 multiplied 10^{-6} TOR or less for a period of 30 days. The test was monitored a minimum of twice daily. The actual combined permeation and leak rate was determined to be 5 multiplied by 10^{-4} cc's/second helium equals 1.87 multiplied by 10^{-4} cc's/second GN_2 . This leak rate was constant throughout the entire test period. The seals were under full compression load during the entire test. Following the thermal vacuum testing of the seals the separation pull test was performed. It was found that a force of 2 pounds greater was necessary to separate the seals after thermal vacuum testing than at ambient conditions prior to the test. The leak rate during the 30 day thermal vacuum testing indicated it would take almost 20 years to lose one pound of oxygen. There was no visible damage to either seal as a result of testing.

The following equipment used in performing the thermal vacuum testing of the docking interface seals was as follows:

- C.V.C. type Cue-20 S/N 1035 6" vacuum pumping system mated to an 18 x 18 inch bell jar capable of 50×10^{-8} TORR.
- C.V.C. type GIC-110B S/N 3008 ionization vacuum gauge. duPont leak detector model 24-120B S/N 1752 coupled to a duPont test port and roughing station Mod. 24-038 S/N 1253.
- Welch pump Model 1397 S/N 5548-97 was used as roughing and backing pump throughout the entire test.
- A.P.I. 0° - 750° Fahrenheit thermocouple controller augmented with a backup thermo-protection cut-off was used to monitor temperature.

- ° Veeco leak test console model MSAC S/N M5993 with a Wallace and Tiernan 0-1500 Millimeters of mercury absolute pressure gauge. (Calib. 27 Feb.1975) was used as an evacuation and backfill station.
- ° cuPont standard leak model 14430-8 S/N 2996 was used for calibration of the helium leak detector throughout the test.

The above items were calibrated in accordance with helium leak testing's quality assurance manual.

3.5 MAINTAINABILITY

Maintainability arises as the most critical factor in the post-production program due both to the nature of the part and intended use of the seal. A partial solution to preserve the integrity and functionality of the seal was to put an extra ring of Kapton within the retained portion of the seal (ref.fig.5). However, care in the handling, trimming and shipment still reigns as a major concern. Notwithstanding, in application of the extra ring of kapton, any mis-handling of the part is immediate cause for rejection. When trimming the part after release from the mold, it is imperative that two individuals be involved to move the seal to prevent wrinkling of the kapton. Furthermore, it is highly suggested that the manufacturer be allowed to bond the seal to the metal retainer portion prior to shipment. This will minimize any damage to the seal after shipment from the seal manufacturer.

4.0 DOCUMENTATION REQUIREMENTS

4.1 DATA REQUIREMENTS LIST

This submittal is under the Data Requirements List No. 3 initial Submission and the 25 additional copies will be submitted after approval.

5.0 RELIABILITY

Silicone Rubber Specialties discovered after we had met all of the requirements of the Work Statement for the control size seals, that we had a critical weakness in reliability because the seals would normally be destroyed during the installation process. After consultation with Mr. Smith of NASA, a solution was found by adding a kapton ring within the foot of the seal (ref.fig.5).

6.0 SAFETY

The seals should offer maximum safety because the results exceeded our best expectations. In the cold test we achieved a seal utilizing 1/10 of the permitted pressure with a leak rate 223 times better than required. At the high temperature testing, we required a pressure of slightly of 1/2 permitted to accomplish (metal-to-metal) contact. During the high temperature adhesion/cohesion test leak test we exceeded leak requirements by over 30,000.

7.0 PERFORMANCE

Control size seals were tested to the NASA Work Statement with the results stated under the applicable paragraph numbers of this report.

EQUIPMENT LIST

<u>Test Description</u>	<u>Equipment Description</u>	<u>Manufacturer</u>	<u>Model Number</u>	<u>I.D. Number</u>	<u>Calibration Last</u>	<u>Calibration Due</u>
Leak Rate	Temp Chamber	Bemco	64 Cubic	3244	8-22-74	2-22-75
	Regulator	Victor	VTS-400E	2059922	Not Required	
	Gauge	Ashcroft	0-60 psi	5377	12-2-74	3-2-75
	Temp. Bridge	L & N	8693	1002	3-1-74	3-1-75
Compression Force	Temp Bridge	L & N	8693	1002	3-1-74	3-1-75
	Gauge	Ashcroft	0-60 psi	5377	12-2-74	3-2-75
	Gauge	Ashcroft	0-200 psi	5406	12-2-74	3-2-75
	Press	Pasadena Hydraulics Co.	72-6-007	Not Required		
	Regulator	Victor	VTS-400E	2059922	Not Required	
	Micrometer	Mitutoyo	2915	3127	1-23-74	1-23-75

TEST DATA

DESCRIPTION

Seal Set No. 34 was constructed of two compounds, SRS No. 4221-4 (Seal to Seal Area) and SRS No. 2270-4 Base or Structural Contact Area. The Seal to Seal Contact Area had a 0.005" kapton lamination.

No cuts, scratches, or deformation of seals were noted.

TEST DATA

Date Started: 12-12-74
 Data Completed: 12-12-74
 Temperature (Laboratory): As Noted
 Humidity (Laboratory): Uncontrolled
 Specimen Number: #34 Set

Customer: NASA Houston
 Specimen Description: Docking Interface Seal
 Leak Rate Type of Test
 Test Specification: Statement of Work
 Paragraph Number: 3.3

TIME	REMARKS
1300	Placed seals in test fixture with seals mismatched 0.098" at seal centers and clearance between docking interfaces of 0.039 inches. At +100°F leakage was less than 0.001 lbs/hr (minimum readable leakage). At -58°F (stabilized) leakage was less than 0.001 lbs/hr. Removed fixture and seals from temp. chamber.
1600	Removed seals from fixture
1730	Installed seals in pre-cooled fixture, slight icing condition was noted under seal and on kapton. Re-stabilized fixture and seals at -58°F. Leakage was less than 0.001 lbs/hr.

Note: All leakage tests conducted with a differential pressure of 16 psi (cabin side)

TEST DATA

Date Started: 12-12-74
 Date Completed: 12-12-74
 Temperature (Laboratory): As Noted
 Humidity (Laboratory): Uncontrolled
 Specimen Number: #34 set

Customer: NASA Houston
 Specimen Description: Docking Interface Seal
 Type of Test: Seal Compression Force
 Test Specification: Statement of Work
 Paragraph Number: 3.1

Fixture Temp. (°F)	Seal Compression (0.001")	Static Loading (lbs)	Cabin Side Pressure (psig)	Remarks
211	0	0	0	
211	0.027	157	16	Leak Rate 0.001 lbs/hr. (sealed) (Note 1)
212	0.058	354	16	
212	0.089	549	16	
212	0.122	746	16	
212	0.126	942.0	16	
212	0.128	1138	16	Metal-to-Metal contact Leak Rate 0.001 lbs/hr (Note 2)

Note (1) Minimum load required for Sealing of Seals -
 4.5 lbs/Lin Inch of Seal.

Note (2) Maximum load required for Metal-to-Metal contact -
 approx. 32.66 lbs/Lin Inch of Seal.

CUSTOMER: NASA - JSC
P.O.# NAS 9-14242

SRS Job #151

SEALS, DOCKING INTERFACE

Sheet #1

MANUFACTURING OUTLINE

Operation

1. Wash tool with M.E.K. or Toluene and finish wipe with D.N.A.
2. Heat tool to a minimum of 250°F and coat with National Chemsearch "Tel-X" spray release agent
3. Allow tool to cool down to room temperature
4. Catalyze silicone on mill and allow one hour minimum cooling before processing
5. Refreshen compound and place on calander
6. Cut three pieces of release paper (Kodacel, Holland Cloth, etc.) 12" wide x 36" long
7. Calader out silicone per SRS compount #4221-4 full length and width of release paper at .030" thick
8. Cut strip of silicone and paper to .400" wide
9. Peel back release paper and preform carefully pressing into base of tool (ref. T-10046-101) and "butt" ends
10. Prime with as thin a coat as possible of Chemlok 607 primer on both sides. Allow to air dry a minimum of 30 minutes in a dust free stmosphere to a maximum of one hour.
11. Lay on top .005" thick x 36" x 36" sheet of kapton
12. Assemble lower plates of tool to base
13. Calander out silicone per SRS compound #2270-4 full length and width of 2nd piece of release paper at .200" thick
14. Cut strip of silicone and paper to .400" wide.
15. Peel back release paper and preform carefully pressing into lower portions of tool (Ref. T-10046-102 & -107) and "butt" ends
16. Assemble upper portions of tool to base and lower portion
17. Calander out silicone per SRS compound #4221-4 full length and width of 3rd piece of release paper at .170" thick
18. Cut strip of silicone and paper to .230" wide
19. Peel back release paper and preform carefully pressing into upper portions of tool (Ref. T-10046-103 & -106) and "butt" ends.

CUSTOMER: NASA - JSC
P.O.# NAS 9-14242

SRS Job # 151

SEALS, DOCKING INTERFACE

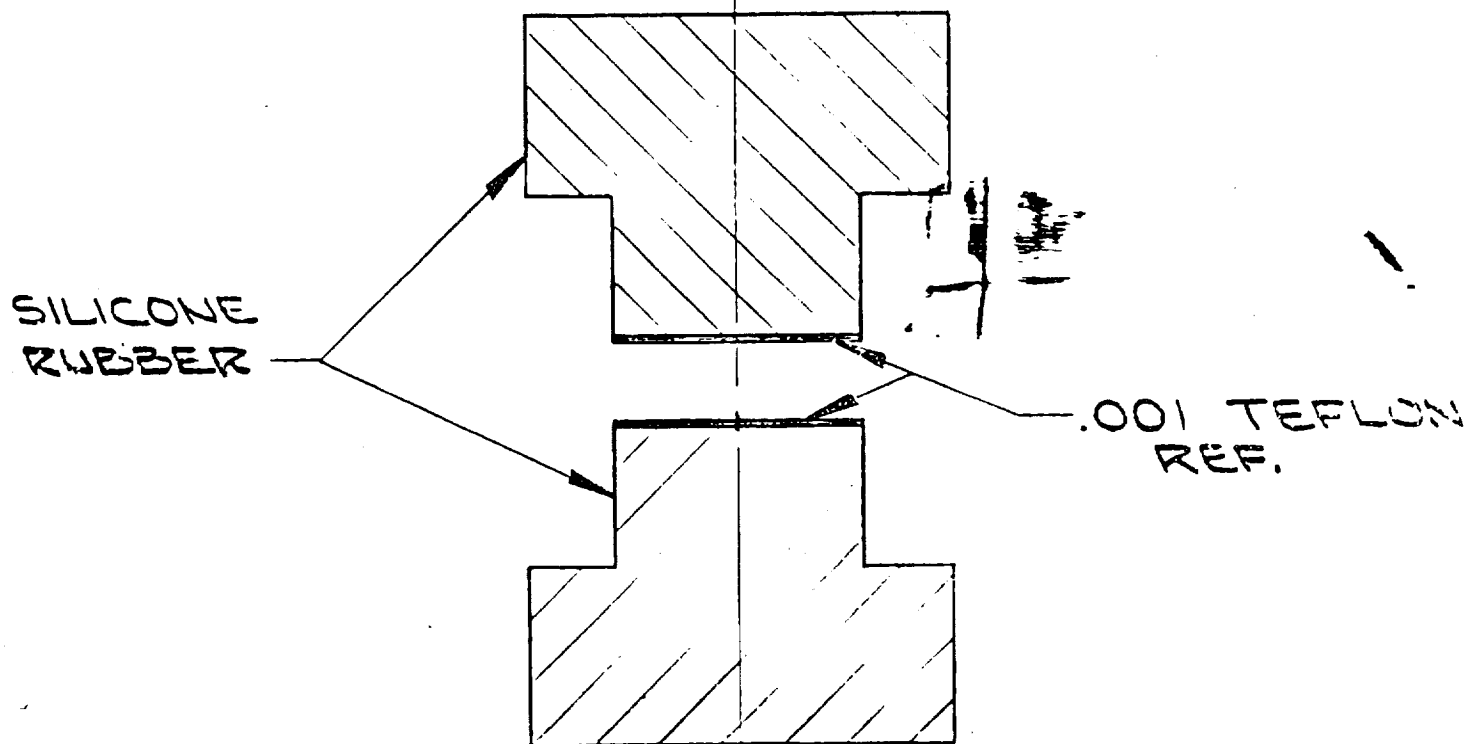
Sheet 2

20. Place .005 thick x 36" x 36" of Kapton, after priming with Chemlok 607 one side only (side next to rubber) and follow instructions in step 11.
21. Place .500" x 36" x 36" plate over tool. See Dwg. T-10046
22. Place in a $340^{\circ} \pm 10^{\circ}\text{F}$ press, "bumping" 5-6 times using closing pressure in excess of 500 psi
23. Cure for 45 minutes
24. Remove from tool taking care not to stretch part
25. Place part on fiberglass covered table and allow to cool for a minimum of 1 hr. before trimming and inspecting
26. Clean part with D.N.A.
27. Place on fiberglass covered oven tray
28. Oven cure for 24hrs at 350°F
29. Remove from air-circulated oven and place in vacuum oven for 48 hrs at 250°F for additional curing
30. Remove and allow a minimum of 4 hrs for cool-down.
31. Trim both pieces of kapton and silicone as required
32. Clean with D.N.A.
33. Inspect finished seal on check fixture for size and check for any non-fill bubbles or flash lines

NOTE:

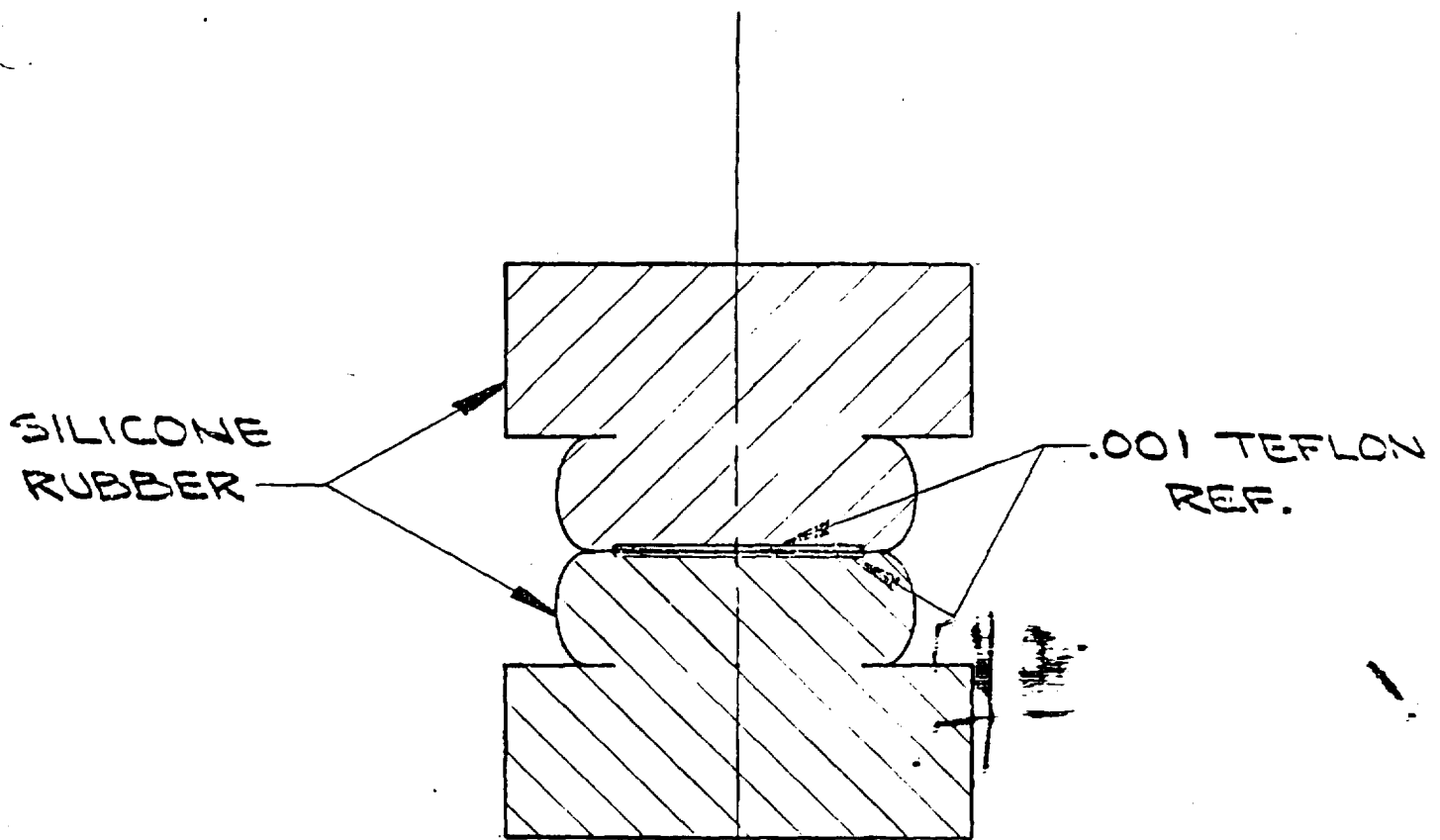
SRS Compound 2270-4 consists of Stauffer Wacker 20 durometer low modulus with varox catalyst.

SRS Compound 4221-4 consists of Stauffer Wacker 40 durometer high strength with varox catalyst.



BASIC SEAL CONFIGURATION

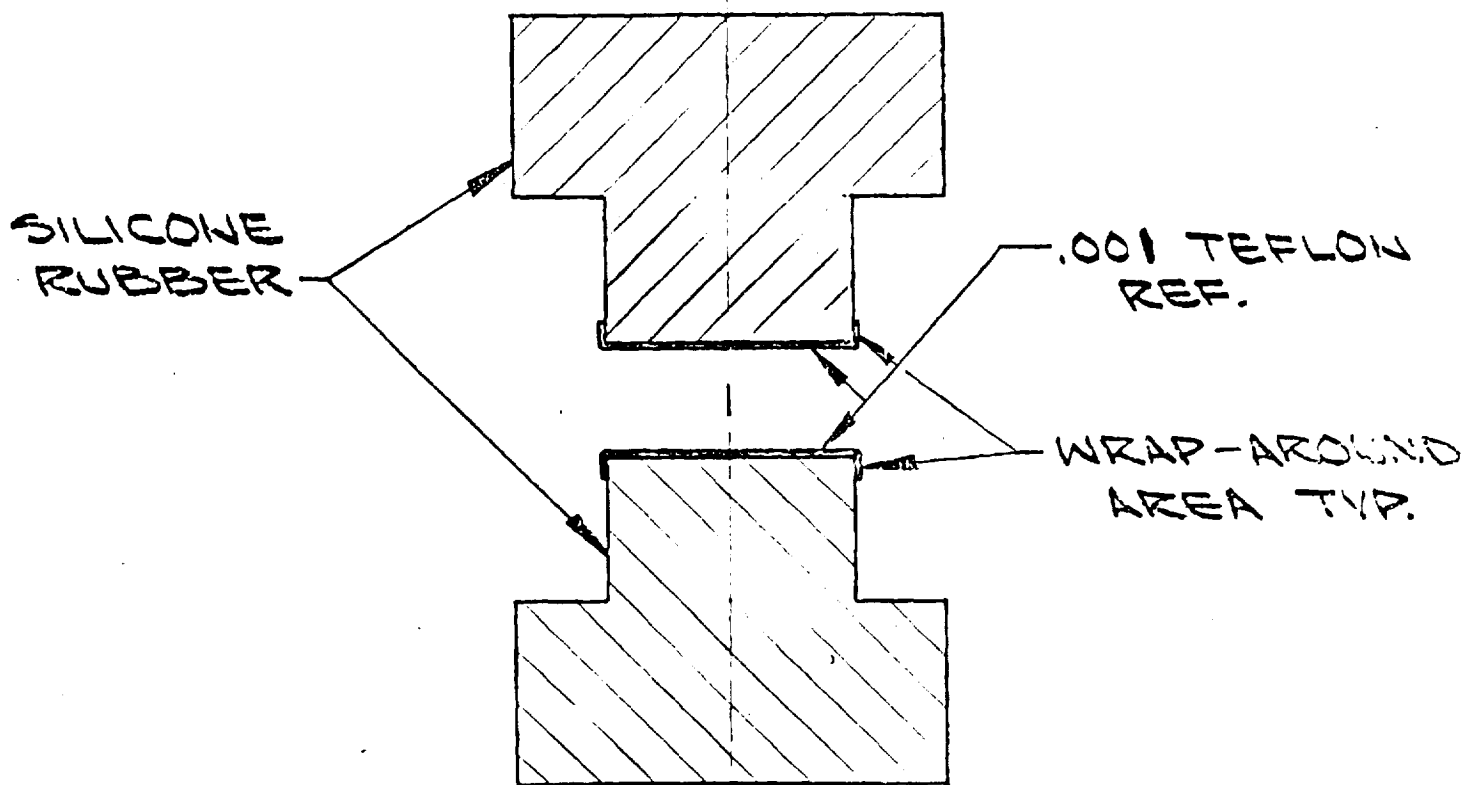
FIGURE 1



NOTE:
TEFLON ELONGATES
UNDER COMPRESSION.

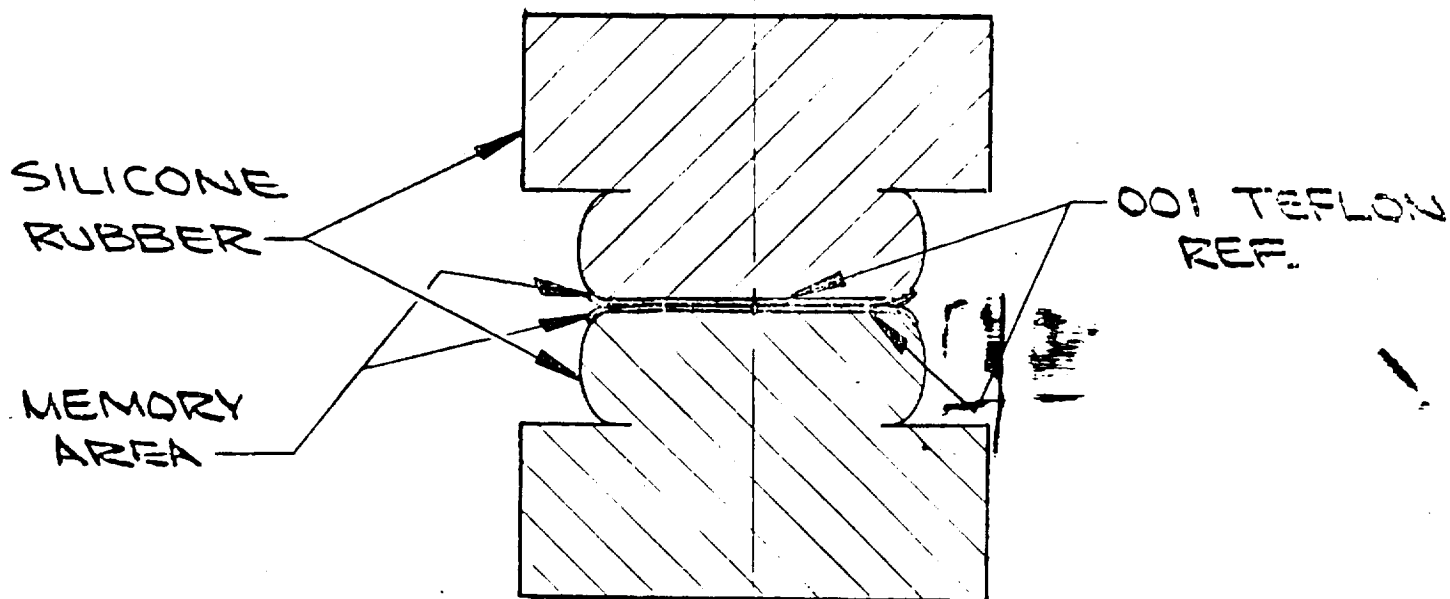
BASIC SEAL CONFIGURATION
UNDER COMPRESSION

FIGURE 2



BASIC SEAL CONFIG. WITH!
TEFLON WRAP-AROUND

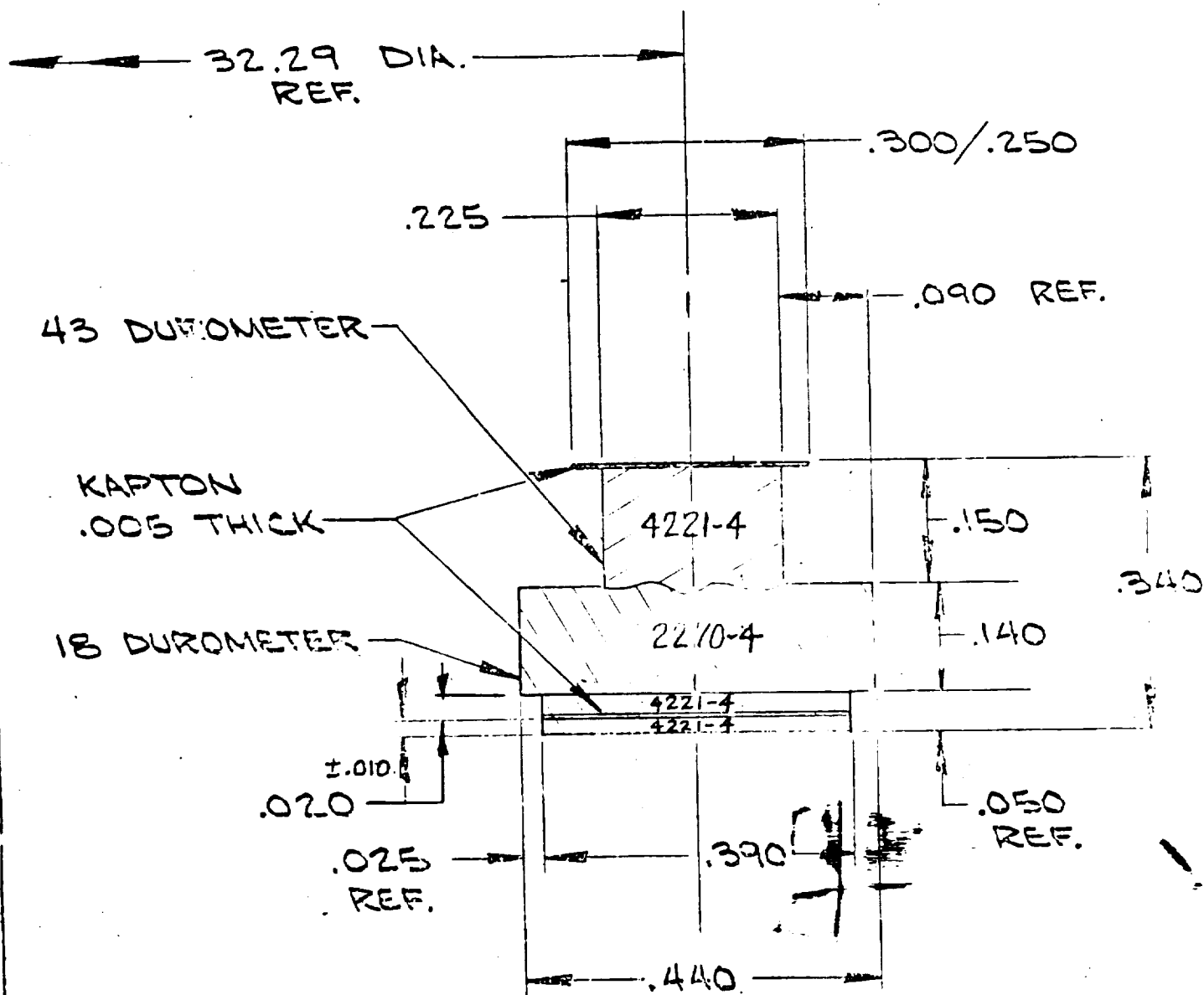
FIGURE 3



NOTE:
TEFLON ELONGATES
UNDER COMPRESSION.

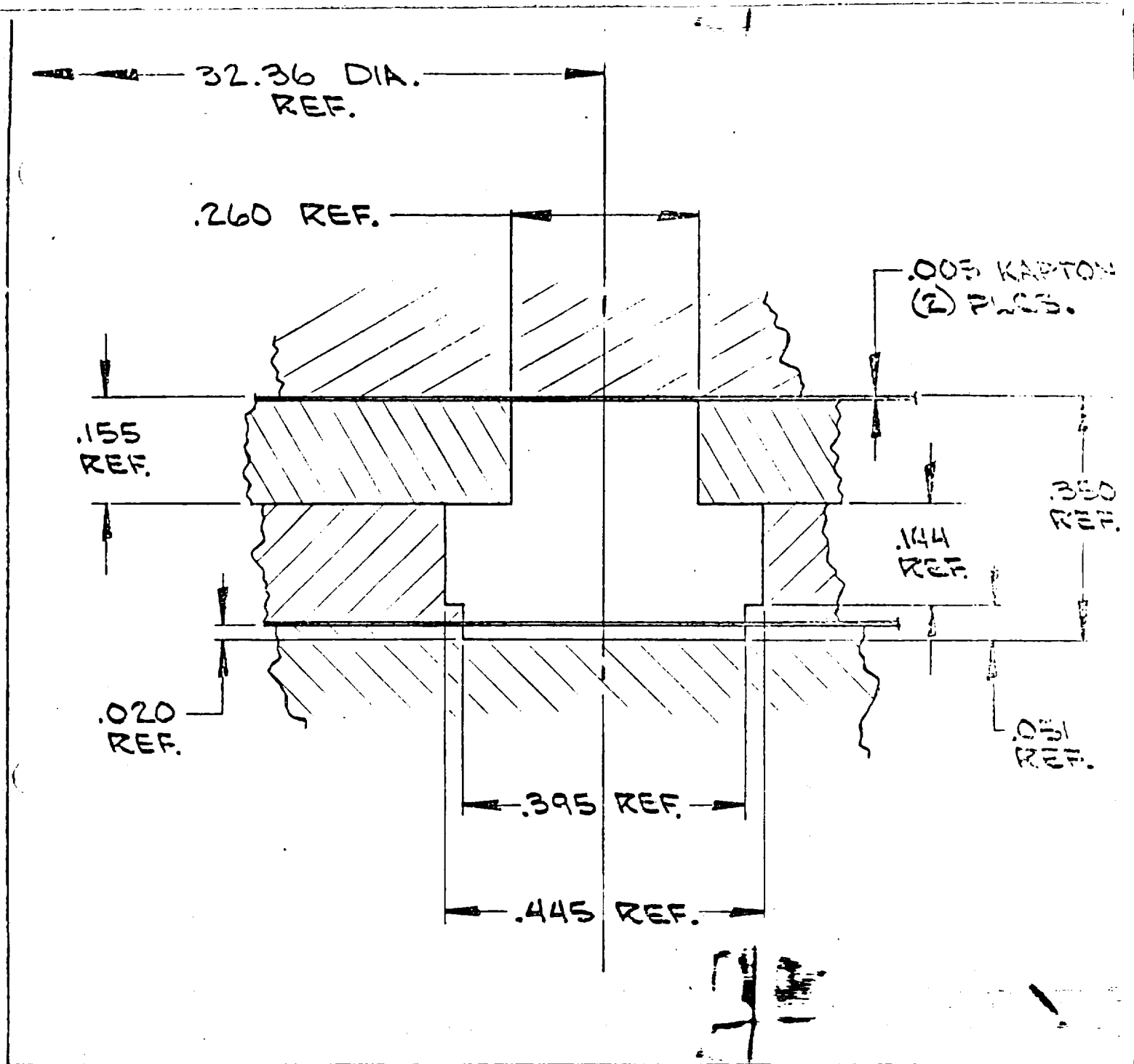
BASIC SEAL CONFIG. WITH
TEFLON WRAP-AROUND
UNDER COMPRESSION

FIGURE 4



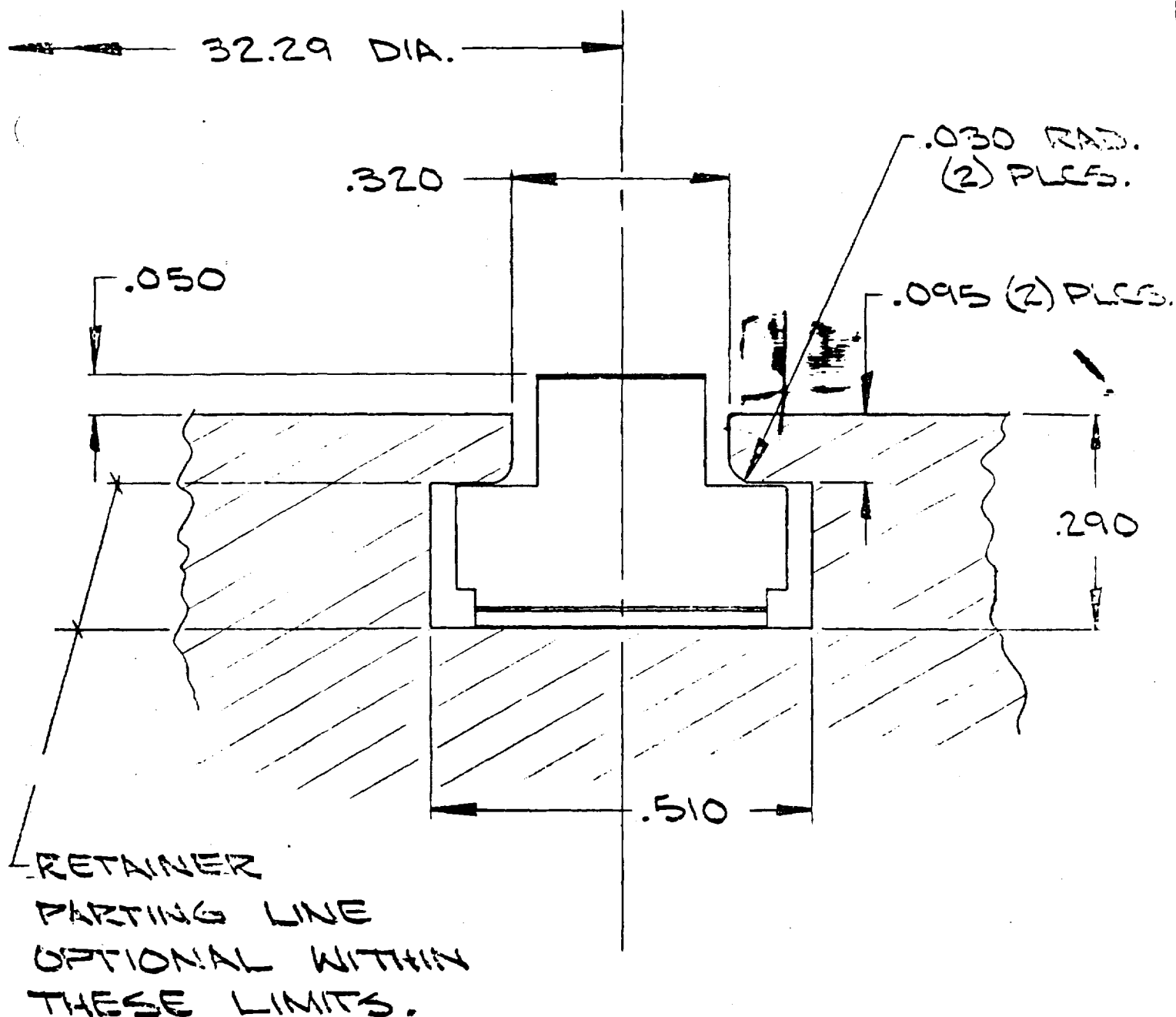
SEAL CROSS SECTION

FIGURE 5



TOOL CAVITY CROSS SECTION

FIGURE 6



SEAL RETAINER CAVITY

FIGURE

TEST REPORT
ON
DOCKING INTERFACE SEALS
FOR
SILICONE RUBBER SPECIALTIES

PREPARED BY
HELIUM LEAK TESTING CO.
8652 Amigo Ave.
NORTHRIDGE, CALIFORNIA 91324

CONTENT

- 1.0 SCOPE
- 2.0 TEST SUMMARY
- 3.0 EQUIPMENT
- 4.0 TEST PROCEDURE

TEST REPORT

1.0 SCOPE

This report summarized and documents the procedures followed in evaluating the Docking Interface Seals in accordance with Silicone Rubber Specifications requirements.

2.0 TEST SUMMARY

- A. The leakage rate did not exceed .001 lbs./hr. = 9.8×10^{-2} cc/sec. GN_2 .
- B. The actual combined permeation and leakage rate was determined to be 5.0×10^{-4} cc/sec. helium = 1.87×10^{-4} GN_2 .
- C. A force of 2 lbs. was necessary to separate the seals after 30 days at temperature and pressure.

3.0 EQUIPMENT

The following equipment was used in performing the thermal degassing of the Docking Interface Seals.

C.V.C. Type CUE-20 S/N 1035 6" Vacuum pumping system mated to an 18" x 18" Bell Jar. Capable of 5.0×10^{-8} Torr.

C.V.C. Type GIC-110B S/N 3008 Ionization vacuum gauge.

DuPont leak Detector Model 24-120B S/N 1752 coupled to a DuPont Test Port and Roughing Station Model 24-038 S/N 1253.

Welch Pump Model 1397 S/N 5548-97 was used as roughing and backing pump through out the entire test.

A.P.I. $0^\circ - 750^\circ$ Fahrenheit thermocouple controller augmented with a backup thermo-protection cut-off was used to monitor temperature.

Veeco Leak Test Console Model MS9C S/N MS993 with a Wallace and Tiernan 0 - 1500 millimeter of mercury absolute pressure gauge (calib. date 27 Feb. 1975) was used as an evacuation and backfill station.

DuPont Helium Standard Leak Model 14430-8 S/N 2996 was used for calibration of the Helium Leak Detector through-out the test.

The above items have been calibrated in accordance with Helium Leak Testing's Quality Assurance Manual.

4.0 TEST PROCEDURE

The Docking Interface Seals were exposed to a temperature of 212°Fahrenheit and a pressure of 1.0×10^{-6} Torr or less for a period of 30 days. The test was monitored a minimum of twice daily. The leakage rate did not exceed .001 lbs./hr. = 9.8×10^{-2} dd/sec. The actual combined permeation and leakage rate was determined to be 5.0×10^{-4} cc/sec. helium = 1.87×10^{-4} N₂. This leakage rate was constant through-out the entire test period. The seals were under full compression load during the entire test and leakage rate determination.

Following the degassing of the seals, the separation pull test was performed. It was found that a force of 2 lbs. greater was necessary to separate the seals after degassing at temperature than at ambient conditions prior to test. There was no visable damage to either seal as a result of testing.

Test Engineer


W.L. Lamar

Quality Control Manager


J.H. Waters

May 1, 1975

Silicone Rubber Specialties Company
349 West Maple Avenue
Monrovia, California 91016

TEST ITEMS

Tooling on NASA Rings

SUMMARY

This report certifies that the test specimens identified above have been subjected to Vacuum Bakeout in accordance with customer instructions.

No adverse effects were noted.

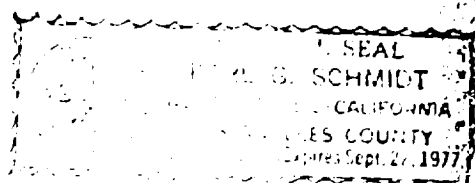
TEST EQUIPMENT

<u>AETL No.</u>	<u>Manufacturer</u>	<u>Instrument</u>
ENV9L	Del Vac Engineering	Thermal Vacuum Chamber, M/N ALICE
ENV624V	Minneapolis Honeywell	Temperature Controller Recorder, M/N DY152C(25)P-242W7-(A3)
V44L	Kinney Vacuum	Thermocouple Gauge, M/N KTG-3

TEST PROCEDURES AND TEST RESULTS

Each specimen, in turn, was placed in a temperature controlled vacuum chamber and was subjected to a temperature of +250°F for a period of two hours. During the two-hour period, the chamber pressure was maintained at less than 1,000 microns.

Visual examination following testing of each specimen revealed no damage or other adverse effects.



STATE OF CALIFORNIA
COUNTY OF LOS ANGELES

JOHN REHARD, Project Manager

being duly sworn, deposes and says: That the information contained in this report is the result of complete and carefully conducted tests and is to the best of his knowledge true and correct in all respects.

SUBSCRIBED and sworn to before me this 22 day of AUGUST, 1975

Notary Public in and for the County of Los Angeles, State of California.

FOR OUR MUTUAL PROTECTION, THE USE OF THIS REPORT, COMPLETE PART, FOR ADVERTISING OR PUBLICITY, MUST BE RECEIVED BY OUR APPROVAL. THIS REPORT DOES NOT BE VALID WITHOUT OUR APPROVAL.



OGDEN TECHNOLOGY LABORATORIES, INC

Subsidiary of Ogden Corporation

8230 HASKELL AVENUE, VAN NUYS, CALIFORNIA 91410
TELEPHONE 213 997-9200

Test Letter Report No. V-74689
13 December 1974

Silicone Rubber Specialties, Co.
339 West Maple Avenue
Monrovia, Calif. 91016

Attention: Mr. P. Mc Partlan

Subject: Docking Interface Seal Evaluation

Reference: 1) Exhibit "A" Statement of Work for the design,
development and manufacture, future Docking
Interface Seals for a manned spacecraft docking
system.

2) SRS Purchase Order Number 0760

This report summarizes and documents the procedures followed in
evaluating the Docking Interface Seals in accordance with the
above references.

SEAL COMPRESSION FORCE (PARA. 3.1)

The seals (sets No. 33 & 34) were placed in the test fixture and
heated to +212°F. A compression force was applied to determine
the range required to maintain a seal. Seal occurred at low
pressure and was maintained to contact (metal to metal) of the
docking interfaces as indicated on the data sheet. The above
sealing was determined as being within the allowable leak rate
(para. 3.3) with a differential pressure of 16 psi GN₂ from the
Cabin Side to the outside as stated in para. 3.2.

LEAK RATE (PARA. 3.3)

Set No. 34 (SRS compound No. 4221-4 on No. 2270-4) was mounted in
the test fixture. Preliminary leakage was 0.001 pounds per hour.
The seals and fixture were reduced in temperature to -58°F and
allowed to stabilize. A differential pressure of 16 psi GN₂
was applied and the leak rate measured. Leakage was 0.001
pounds per hour GN₂.

ODDEN TECHNOLOGY LABORATORIES, INC.

Test Letter Report No. V-74689

13 December 1974

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Set No. 33 (SRS Compound No. 4221-4) was placed in the test fixture. Preliminary leakage was taken at approximately -10°F and found to be greater than 0.223 pounds per hour. The temperature was further reduced to -58°F and leakage again measured at 16 psi differential pressure. Leakage was greater than 0.223 pounds per hour.

SUMMARY

Seals, Set No. 33 passed, seal compression force, pressure range and failed leak rate.

Seals, Set No. 34, passed all tests.

There was no visible damage to either set as a result of testing.

JOHN F. KERR, JR. LABORATORIES, INC.

Test Letter Report No. V-74889
13 December 1974
Page 3

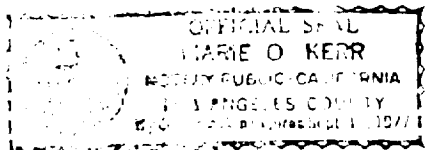
SIGNATURE PAGE

(Print Name and Title)
(County of Los Angeles)

I, John F. Kerr, Jr., being duly sworn, deposes and says: That the information
contained in this report is the result of complete and carefully con-
ducted tests and is to the best of his knowledge true and correct in
all respects.

John F. Kerr, Jr.
R. E. Kerr, Jr. Mechanics Supervisor
John F. Kerr, Jr. Laboratories, Inc.
San Diego Division

SUBSCRIBED and sworn to before me
this 13th day of December, 1974



Marie O. Kerr
Marie O. Kerr

William J. Ferris
William J. Ferris
District Control Supervisor



TEST DATA

DATE STARTED	CUSTOMER	TECHNICIAN (SIGNATURE)
	SILICONE RUBBER SPECIALTIES CO.	
DATA COMPLETED	SPECIMEN DESCRIPTION	ENGINEER (SIGNATURE)
	DOCKING INTERFACE SEAL	
TEMPERATURE (LABORATORY)	TYPE OF TEST	ENGINEER
HUMIDITY (LABORATORY)	TEST SPECIFICATION	JOB NUMBER
	PARAGRAPH NUMBER	
SPECIMEN NUMBER		

DESCRIPTION	
	TWO SEAL SETS, NO'S 33 AND 34
	WERE SUBMITTED FOR TEST.
	SEAL SET NO 33 WAS CONSTRUCTED OF A
	SINGLE SILICONE COMPOUND, SRS NO. 4221-4
	WITH A KAPTON FILM OF 0.005" THICK WITH
	SRS NO. 4221-3 AT THE SEAL TO SEAL CONTACT
	AREA.
	SEAL SET NO 34 WAS CONSTRUCTED OF
	TWO COMPOUNDS, SRS NO. 4221-4 (SEAL TO SEAL
	AREA) AND SRS NO. 2270-4 BASE OR
	STRUCTURAL CONTACT AREA. THE SEAL TO SEAL CONTACT
	AREA HAD A 0.005" KAPTON LAMINATION BONDED
	WITH 0.010" THICK COMPOUND SRS NO. 4221-3.
	NO CUTS, SCRATCHES, OR DEFORMATION OF
	SEALS WERE NOTED.



TEST DATA

DATE STARTED 12-12-74	CUSTOMER SILICONE RUBBER SPECITIES CO.	TECHNICIAN (SIGNATURE) R. K. Newell
DATE COMPLETED 12-12-74	SPECIMEN DESCRIPTION DOCKING INTERFACE SEAL	ENGINEER (SIGNATURE) R. K. Newell
TEMPERATURE (LABORATORY) As Noted	TYPE OF TEST SEAL COMPRESSION FORCE	ENGINEER R. K. NEWELL
HUMIDITY (LABORATORY) Uncontrolled	TEST SPECIFICATION STATEMENT OF WORK	JOB NUMBER U-74689
SPECIMEN NUMBER #33 Set	PARAGRAPH NUMBER 3.1	

[illegible]



TEST DATA

DATE STARTED 12-12-74	CUSTOMER SILICONE RUBBER SPECILITIES CO	TECHNICIAN (SIGNATURE) R.K. Newell
DATA COMPLETED 12-12-74	SPECIMEN DESCRIPTION DOCKING INTERFACE SEAL	ENGINEER (SIGNATURE) R.K. Newell
TEMPERATURE (LABORATORY) As Noted	TYPE OF TEST SEA LEAK RATE	ENGINEER R.K. NEWELL
HUMIDITY (LABORATORY) Uncontrolled	TEST SPECIFICATION STATEMENT OF WORK	JOB NUMBER V-74689
SPECIMEN NUMBER # 33 SET	PARAGRAPH NUMBER 3.3	

TIME	REMARKS
1615	Installed Seals in pre cooled Fixture and placed Fixture in temperature chamber. Preliminary leakage was measured at -10°F . Leakage was in excess of 0.223 lbs/hr. Removed Fixture. Checked misalignment and gap. Aligned Seals to 0° offset. De stabilized to -58°F - Leakage was greater than 0.223 lbs/hr.
1720	Removed seals from chamber and Fixture.
	Note: All leakage tests were conducted with a differential pressure of 16 PSI (Cabin Side) and of GN_2



TEST DATA

DATE STARTED 12-12-74	CUSTOMER SILICONE RUBBER SPECIALTIES CO	TECHNICIAN (SIGNATURE) <i>R. H. Newell</i>
DATA COMPLETED 12-12-74	SPECIMEN DESCRIPTION DOCKING INTERFACE SEAL	ENGINEER (SIGNATURE) <i>R. H. Newell</i>
TEMPERATURE (LABORATORY) As Noted	TYPE OF TEST LEAK RATE	ENGINEER R. H. NEWELL
HUMIDITY (LABORATORY) Uncontrolled	TEST SPECIFICATION STATEMENT OF WORK	JOB NUMBER V-74689
SPECIMEN NUMBER # 34 SET	PARAGRAPH NUMBER 3.3	

TIME	REMARKS
1300	Placed seals in test fixture with seals mismatched 0.098" at seal centers and clearance between docking interfaces of 0.039 inches. At +100°F leakage was less than 0.001 lbs/hr (minimum readable leakage) At -58°F (Stabilized) leakage was less than 0.001 lbs/hr. Removed fixture and seals from temp. chamber.
1600	Removed seals from fixture
1730	Installed seals in pre-cooled fixture. Slight icing condition was noted under seal and on Kapton. Re-stabilized fixture and seals at -58°F. Leakage was less than 0.001 lbs/hr.
	Note: All leakage tests conducted with a differential pressure of 16 PSI (Cabin Side)



EQUIPMENT LIST

JOB NUMBER 1-74689

TEST DESCRIPTION	EQUIPMENT DESCRIPTION	MANUFACTURER	MODEL NUMBER	I.D. NUMBER	CALIBRATION LAST	CALIBRATION DUE
Leak Rate	Temp Chamber	Bemco	64 cubic	3241	8-22-74	2-22-75
	Regulator	Victor	VTS-400E	2059922	Not Required	
	Gauge	Ashcroft	0-60 PSI	5377	12-2-74	3-2-75
	Temp Bridge	L & N	8693	1002	3-1-74	3-1-75
Compression Force	Temp Bridge	L & N	8693	1002	3-1-74	3-1-75
	Gauge	Ashcroft	0-60 PSI	5377	12-2-74	3-2-75
	Gauge	Ashcroft	0-200 PSI	5406	12-2-74	3-2-75
	Press	Pasaden Hydraulic Co.	72-6-007	NOT REQUIRED		
	Regulator	Victor	VTS-400E	2059922	Not Required	
	Micrometer	Mitutoyo	2915	3127	1-23-74	1-23-75